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VERIFICATION OF A HYPOTHESIS CONCERNING THE TYPE - 3 C 273 RADIOSOURCES

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VERIFICATION OF A HYPOTHESIS CONCERNING THE TYPE-3C 273 RADIOSOURCES*

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SUMMARY

This is a statistical verification of the hypothesis according to which the sources of energy produced from type-3C 273 radiosources are stars exploding as supernovae. Brightness observations of 3C 273 allow to obtain the number N of stars that explode per day, $0.5 < N < 1$.

author

* ******* *

There exist several variants of the hypothesis whereby the nature of radiosources of the type 3C 273 might be explained by the explosion of supernovae, or at least of objects liberating an energy of the order of magnitude of a supernova.

Burbridge [1] assumed that for the enormous stellar density in the cores of the powerful extragalactic sources a trigger mechanism induces the explosion of stars as if they were supernovae. According to [2] Woltjer, the release of energy by type-3C 273 radiosources may be explained by admitting a stellar collision attended by energy liberation of the order of magnitude of a supernova. According to [2], and more particularly to the Hoyle discussion, the number of collisions is 10^3 per annum. The stellar collisions which liberate an energy of $2 \cdot 10^{49}$ erg have been considered by Ulam and Walden [3]. The work by Field [4] is more detailed. This author studied the statistical character of brightness variations of 3C 48. He considers that 100 supernovae explode annually.

It is possible to make a statistical evaluation of the hypothesis considered, according to which the energy sources of radiosources represent in fact objects liberating an energy of the order of magnitude of a supernova.

* Vérification d'une hypothèse concernant les radiosources du type 3C 273.

Let us assume that N supernovae explode during a time interval Δt as an average. Their number follows in the various time intervals a Poisson distribution. One may easily obtain for a specific value of N the corresponding probabilities of realization in a given time interval of $N-k$ $(k=1, 2, ., N)$ and $N+k$ $(k=0, 1, \ldots)$ explosions

$$p(x)=\frac{e^{-N}N^{x}}{x!} \qquad (x=0, 1, 2, \ldots).$$

On the other hand, if we admit a certain calibration curve of supernovae after the explosion, we may find the average emission for the object of which the produced energy is obtained during the explosion of the supernova. Therefore, if there are in the time interval Δt $N \pm k$ $(k \neq 0)$ explosions and not N, we may determine the corresponding variation relative to the mean brightness.

We have assumed the following model of brightness variation of supernovae. The supernova acquires instantaneously the maximum brightness, followed by a decrease of brightness by 0.1 mg per day in the course of three minutes after the maximum. For the following 5 minutes the variation is +0.02 mg per day. Thus we consider the supernova until the 280th day after its explosion. In its general order our model is in agreement with the observations of supernovae (1st type) [5] and also with other observations.

Let us consider the stationary case of N stars in the interval Δt, $(\Delta t = 1$ day). If we assume that the average brightness curve is represented by the sum of brightnesses of stars having exploded at the moment of time immediately preceding the explosion of the following star, we will be in the position to write for the mean brightness :

$$\mathfrak{J}_0^{(N)}=\Lambda\left(\sum_{\nu=1}^{30N}\rho^{-\frac{0,1}{N}\nu}+\rho^{-3}\sum_{\mu=1}^{250N}\rho^{-\frac{0,02}{N}\mu}\right),$$

where A is the true brightness of a supernova at its maximum and $\log\rho=0{,}4$.

The fundamental hypotheses which we propose to verify are $N = 30$, 10, 5, 3, 1, 0.5 and 0.1 stars per day. For a given value of N we may, after having computed the mean brightness, find the brightness for the case where $N \pm k$ stars would have exploded. In the final analysis we shall determine the corresponding variation of brightness expressed in stellar magnitudes measured starting from the mean brightness. Tables of probabilities according to [1] were given for the values of $N \pm k$. For $N = 0.5$ and 0.1 stars per day we have computed the p (z) corresponding ones, normalized to the unity, by means of the function Π.

Fig. 1 reproduces the final results for brightness differences expressed in stellar magnitudes, of the mean brightness for the different hypotheses. It is clear that the differences must be least for $N = 30$ and greatest for $N = 0.1$ stars per day. The same figure gives us the possibility of finding the most convincing hypothesis by means of observation data. Because of important variations of Δm for $N = 0.5$ and 0.1, certain points of these curves may be disconnected, as is shown in dashes in the figure : the intermediate probabilities are, however, not equal to zero. We may obtain the nearest discrete values if we carry out calculations for p (x) with $N = 0.5$ and 0.1 by sections of Δm smaller than 0.1 mg.

We utilized the observations of 3 C 273 published in [6, 7, 8]. We thus found in [6] the observations by Smith and Hoffleit. The comparison between the photometric systems indicates that there is no important difference of any kind. Unfortunately, the observations of [9] differ strongly by the photometric system utilized. Nor can we take advantage of the precise photoelectric observations of [10]. The total number of observations utilized is 291.

The final frequency curve is rattached to $\Delta m = 0$ (the mean value of observations is $\bar{m} = 12.60$ mg). We may see that the observation curve is located between the curves of the hypotheses $N = 1$ and $N = 0.5$. The corresponding frequencies to the left and to the right of $\Delta m = 0$ for the observations and for $N = 0.1$, 0.5, 1, 3 and 10 are compiled in Table 1. The frequencies observed are situated between $N = 0.5$ and $N = 1$.

TABLE 1

N	$\Delta m > 0$	$\Delta m < 0$
0.1	27.9 %	72.1 %
0.5	42.9	57.1
Obs	46.1	53.9
1	55.2	44.8
3	53.5	46.5
10	49.7	50.3

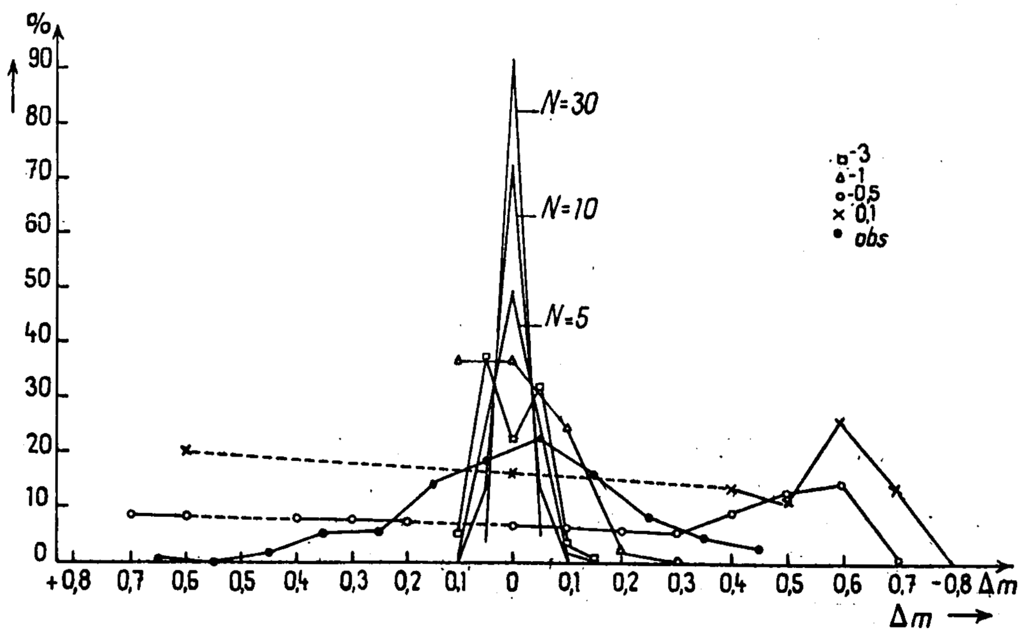

Fig. 1

CONCLUSIONS AND REMARKS.

1. - If the energy of 3 C 273 is produced by the explosion of stars as supernovae, we shall have : 0.5 stars per day $< N < 1$ star per day. Taking into account the fact that the consumption of energy of radiosources is 10^{45} erg/s $< E < 10^{46}$ erg/s, the energy of an explosion must be of $\sim$ $\sim 5.8 \cdot 10^{50}$ erg. This energy corresponds, with the approximation of about one order of magnitude, to the energy liberated during the explosion of a supernova. According to Field [4], $N = 100$ stars per year, which constitutes a number close to our results.

2.- We have assumed in the course of our analysis : a) that supernovae acquire their maximum brightness instantaneously and b) that the mean brightness is that of the stationary case at the moment of time preceding the explosion of the next supernova. In reality, when the conditions a) and b) are not filfilled, the theoretical curves of Fig. 1 must be drawn closer around $\Delta m = 0$. This does not modify in any way the final evaluation of N.

3. - Some of the observation values for the stellar magnitude of 3C 273 which we have utilized represent averages of several determinations. Their influence on the observation curve of Fig. 1 does not alter the evaluation of N either.

**** THE END ****

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